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An Efficient Video Watermarking techniques using Wavelet Packet Transform and Extraction by ICA

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Abstract- The protection and illegal redistribution of digital media has become an important issue in the digital era. This is due to the popularity and accessibility of the Internet nowadays by people. This results in recording, editing and replication of multimedia contents. Digital watermarking can be used to protect digital information against illegal manipulations and distributions. Many literatures have reported about Discrete Wavelet Transform (DWT) based watermarking techniques for data security. However, DWT based watermarking schemes are found to be less robust against video processing attacks. Hence, this paper presents the state of the art in video watermarking techniques based on Wavelet Packet Transform (WPT) and extraction using Independent Component Analysis (ICA). The real time multimedia video sequence is converted into video frames, each frame is decomposed into various sub-bands using WPT. The watermark is embedded in a particular wavelet packet sub-band based on the value of Peak Signal to Noise Ratio (PSNR). This technique provides a robust solution when compared to DWT technique. The proposed scheme generates high PSNR value even in the presence of salt & pepper noise and rotation. An intelligent blind technique namely, FastICA is implemented for extracting the watermark. From the simulation results, it is revealed that wavelet packet transform performs better when compared to DWT. In addition, it addresses the main key performance indicators which include robustness, speed, capacity, fidelity, imperceptibility and computational complexity.

Keywords: Video watermarking, Wavelet transform, Wavelet packet transform, Independent component analysis, Attacks.

I. Introduction

The digital revolution has changed the paradigm of multimedia distribution. High quality copies of digital data are produced and distributed through the internet by exploiting recent network and software technologies. A broad range of application achieved for video such as video broad casting, video conferencing, DVD, video on-demand and high definition TV which has made a security issues,videos can be tampered, forged or altered easily. Illegal acts such as tampering, forging and altering violates the copyright and the security in respect with cases of authentication . Security techniques that are based on cryptography only provide assurances for data confidentiality, authenticity, and integrity during data transmission through a public channel such as transmission through an open network. However, such security techniques do not provide protection against unauthorized copying or transmitting of illegal materials. Copyright protection inserts authentication data such as ownership information and logo in the digital media without affecting its perceptual quality. Watermarking is one of the widespread techniques to authenticate a digital media. Watermarking is the process of inserting some owner’s authentication information in digital media without affects the visual impression of the original multimedia content. Imperceptibility and robustness nearby attacks are the basic concern in digital video watermarking techniques. Various digital watermarking systems have been projected for video because it have the distinguish characteristics for instance temporal and interference which involve the separate content for the video watermarking [2].

Video watermarking is implemented by two different fields one is spatial content of the video based and another one is frequency content of the video based. The spatial based video watermarking is an entire image pigments are used for watermarking procedures [6]. It has the drawback of low robustness

again a several attacks. So in this paper, we apply the working frequency version of the video content in some pixels level only to achieve the frequency version of the video content the mathematical transformation using wavelet packet transform (WPT) and Independent Component Analysis (ICA). Wavelet Packet Transform (WPT) is another way of decomposing signal or image into various sub-bands with high resolution [3,4]. It differs from DWT by decomposing the high pass filtered output along with the low pass filtered output, thereby providing more sub-bands for data hiding. The watermark is embedded in the perceptual model with stochastic approach. Inserting the watermark in low frequencies attained by wavelet packet decomposition enhances the robustness with respect to attacks. Besides, an intelligent detection technique based on ICA is implemented for extraction without the use of previous knowledge of the watermark and even the transformation process [5,6]. Robustness against various attacks like salt and pepper noise and rotation of the proposed scheme are demonstrated with simulation results. The rest of the paper is organized as follows: section II presents the proposed watermarking scheme. Section III introduces the experimental results and finally section IV concludes the paper.

II. proposed system

In this paper it is proposed to implement WPT and then applying Independent Component analysis to it. To achieve more robustness watermark is embedded in the sub-bands of WPT.

A. Wavelet Packet Transform

Discrete wavelet transform decomposes an image or a video frame into sub-images. 1 level discrete wavelet transform decomposes an video frame into sub-images. DWT splits the frequency band of an image into a lower resolution approximation sub-band (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) detail components[8]. Wavelet packet transform is a generalization of the DWT and in wavelet transform, only the low pass filter is iterated. It is assumed that lower frequencies contain more important than higher frequencies. This assumption is not true for many signals [8]. The main difference between the wavelet packets transform and the wavelet transform is that, in the wavelet packets, the basic two-channel filter bank can be iterated either over the low-pass branch or the high-pass branch as shown in Fig. 2. This provides an arbitrary tree structure with each tree corresponding to a wavelet packet basis. Wavelet packet bases are designed by dividing the frequency axis in intervals of varying sizes. These bases are thus particularly well adapted to decomposing signals that have different behavior in different frequency intervals. Here, in the case of wavelet packets, the sub-band information represented by the approximation and detail co-efficients like LL1, LH1, HL1 and HH1 are decomposed further as shown in Fig.2. The advantages of these further series of operations are that the time frequency plane is partitioned more precisely. A two level wavelet packet transform generates 16 sub-bands of coefficients comprising LLA2 through HHD2 as shown in Fig. 2. This sub-band decomposition provides more resolution in time and thereby increases the robustness and imperceptibility of the watermarking scheme. Hence, in this paper wavelet packet based video watermarking is proposed and implemented.

III. Independent Component Analysis

ICA is a statistical technique for obtaining independent sources S from their linear mixtures X, when neither the original sources nor the actual mixing A are known. The result of the separation process is a demixing matrix W, which can be used to obtain the estimated unknown sources, $\bar{S}$ from their mixtures.

A.Fast ICA algorithm

Aapo Hyvarinen and Erkki Oja have proposed an Fast ICA algorithm and it is based on a fixed-point iteration scheme [8]. The operation of FastICA algorithm is outlined as follows:

i) The mean of the mixed signal X is subtracted so as to make X as a zero mean signal as

$$X = X - E[X] \quad (1)$$

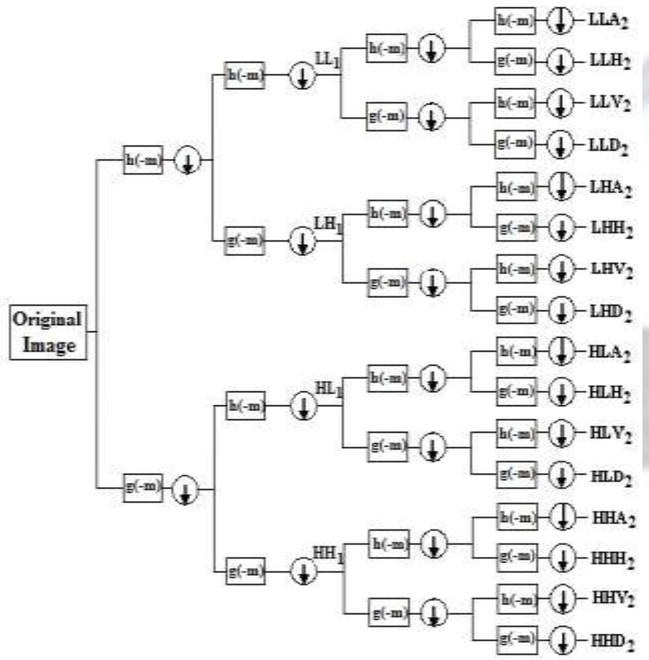


Figure 1: Two level decomposition using WPT

ii) Then covariance matrix is

$$R = E[XX^T] \tag{2}$$

is obtained and eigen value decomposition is performed on it and is given by

$$R = EDE^T \tag{3}$$

where E is the orthonormal matrix of eigenvalues of R and D is the diagonal matrix of eigenvalues. Find the whitening matrix, P which transforms the covariance matrix into an identity matrix is given by

$$P = Inv\left(sqrt(D) \times E^T\right) \tag{4}$$

iii) Choose an initial weight vector W, such that the projection $W^T X$ maximizes non gaussianity as

$$W^+ = E\left\{X * g\left(W^T X\right)\right\} - E\left\{g'\left(W^T\right)\right\}W \tag{5}$$

The variance of $W^{+T} X$ must be made unity.

$$W = W^+ / \left\|W^+\right\| \tag{6}$$

If W not converges means go back to step (iv).

iv) The demixing matrix is given by

$$W = W^T \times P \tag{7}$$

and independent components are obtained by

$$\bar{S} = W \times X \tag{8}$$

IV. Embedding Procedure

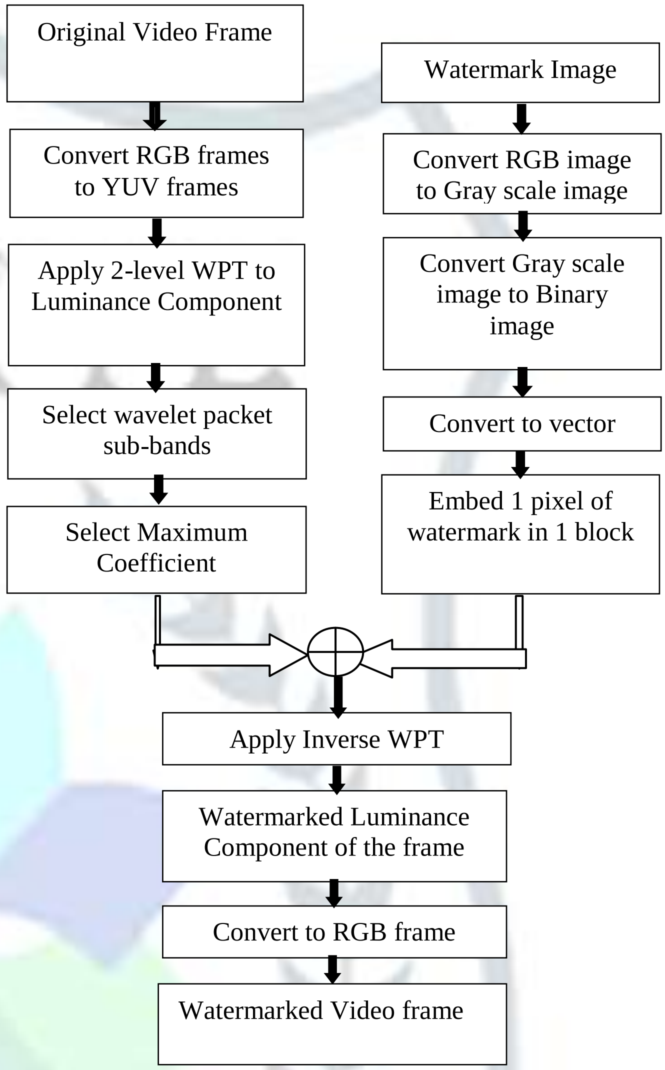
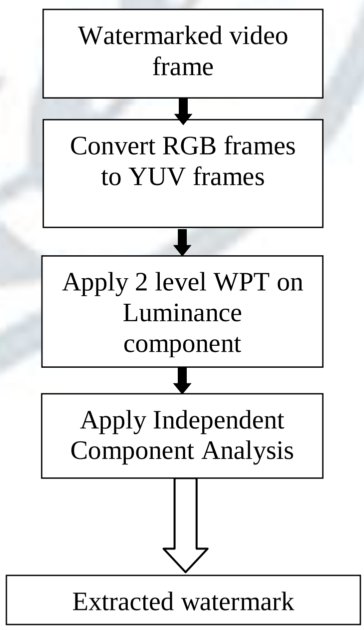


Figure 2 : Watermark Embedding

V. Extraction Procedure



VI. Experimental Results

A Color video is tested in our proposed technique and is shown in Fig. 4. The Input video is converted into various frames of size 512 x 512 that is converted to 256 x 256 frame size by 1 level WPT and further modified to 128 x 128 frame size by taking 2 level WPT. The watermark is embedded using the equation (9) and PSNR value is calculated using the equation (10) in all frames. 8^{th} frame is selected due to high PSNR value and is shown in Fig. 5. RGB frame is converted to YUV frame as in Fig. 6. Two level WPT is shown in Fig.7. A RGB watermark (stamp image) of size 128 x 128 is considered and is converted to Y frame as shown in Figs. 8 and 9 respectively. The watermark is embedded in the sub-band of two level WPT in the HLV2 sub- band and watermarked video is shown in Fig. 10. The robustness of the above watermarking scheme is validated against attacks like Gaussian noise, salt and pepper noise and rotation as shown in Figs. 11-13. After applying FastICA watermark is extracted from the watermarked frame and is shown in Fig. 14.

$$I'HLV_2(i,j) = HLV_2(i,j) + .\alpha.\ W(i,j) \qquad (9)$$

Figure 4. Input video

Figure 5. 8th frame of the Input video

Figure 6. Y component of 8th frame

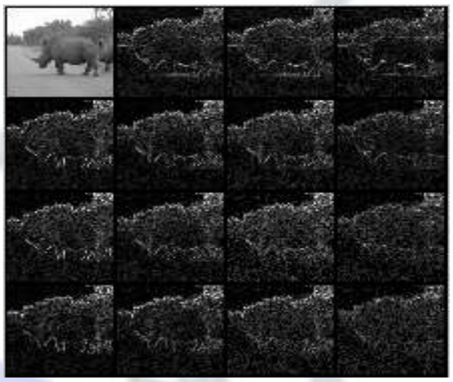


Figure 7.Two level WPT decomposition

Figure 8. Watermark

Figure 9.Y component of watermark

Figure 10. Watermarked frame

Figure 11 : Gaussian noise

Figure 12 : Salt & Pepper noise

Figure 13 : Rotation

Figure 14 : Extracted Watermark

$$PSNR = 10\log_{10}\frac{255^2}{MSE}(dB) \tag{10}$$

$$NC = \frac{\sum_{m=0}^{M-1}\sum_{n=0}^{N-1} x(m,n)\, \hat{x}(m,n)}{\sum_{m=0}^{M-1}\sum_{n=0}^{N-1} x^2(m,n)} \qquad (11)$$

Table 1. Performance comparison of DWTand WPT

Frames	Discrete Wavelet Transform		Wavelet Packet Transform	
	PSNR	**NC**	**PSNR**	**NC**
Watermarked	43.0457	0.8998	45.7877	0.9588
Gaussian Noise	34.4572	0.8867	36.5490	0.9144
Salt & Pepper noise	33.5763	0.8809	38.9034	0.9085
Rotation	32.1256	0.8742	35.4421	0.9335

VII. Conclusion

In this paper, an attempt is made to implement wavelet packet based video watermarking and extraction using FastICA. Here, in this work, Rhino is considered as input video and stamp as color watermark. The performance of Wavelet Packet is compared with Wavelet transform. From the results, it is proved that Wavelet Packet posses a high PSNR value compared to Wavelet transform. Also in extraction, it is concluded that the performance of Wavelet Packet is superior to Wavelet transform in terms of Normalized coefficient. The robustness of the proposed scheme is also evaluated against various image processing attacks.

VIII. References

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